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Materiel Test Procedure 5-3-509
U. S. Army Air Defense BoardU. S. ARMY TEST AND EVALUATION COMMAND
COMMON SERVICE TEST PROCEDURE4054
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ADEQUACY OF LIGHTING, VENTILATION,
AIR CONDITIONING, AND HEATING EQUIPMENT1. OBJECTIVE

The objective of this Materiel Test Procedure (MTP) is to describe the service test procedures required to determine the adequacy of environmental provisions within manned enclosures of military vehicles and equipment, and to evaluate the performance of crews operating therein compared with requirements of Qualitative Materiel Requirements (QMR), Small Development Requirements (SDR), Technical Characteristics (TC), or other applicable specifications for the subject equipment.

2. BACKGROUND

Army personnel are assigned to perform tasks which may be demanding in terms of concentration and precision, to be carried out (while protected from unfriendly forces), in ambient environmental conditions in compartments of combat vehicles, cabs, vans, trailers, or other items of military equipment. Such compartments must be provided with artificial environment control, including lighting, ventilation, air conditioning, and heating, in order to maintain crew proficiency at levels commensurate with the demands of assigned tasks, and in some cases to protect equipment such as electronic gear from overheating or other adverse thermal effects, dust and fumes.

Comprehensive evaluation of new or improved environmental provisions, and of new or improved commodity items so equipped, will be carried out in conjunction with other service tests of the subject commodity item. The procedures contained in this MTP enables these evaluations to be conducted in accordance with uniform standards, and with least interference with other service test operations.

3. REQUIRED EQUIPMENT

- a. Suitable Maintenance Facilities.
- b. Spare Parts and Special Tools for Environmental Control Equipment.
- c. Measuring Tapes.
- d. Sound Level Recorder.
- e. Portable Air Flow Gage.
- f. Photometer.
- g. Elapsed Time Indicator.
- h. Recording Psychrometer (wet bulb) for Compartment Relative Humidity.
- i. Still Camera and Film.
- j. Voice Recorder and Tape.
- k. Meteorological Instrumentation.
- l. Support Vehicles and associated equipments.

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4. REFERENCES

- A. AR 70-10, Army Materiel Testing.
- B. AR 70-38, Research, Development, Test and Evaluation of Materiel for Extreme Climatic Conditions.
- C. AR 705-50, Army Materiel Reliability and Maintainability.
- D. USATECOM Regulation 705-4, Equipment Performance Report.
- E. TB MED 251, Noise and Conservation of Hearing.
- F. MIL-STD 1472, Human Engineering Design Criteria for Military Systems, Equipment and Facilities.
- G. MTP 4-3-501, Personnel Training.
- H. MTP 5-3-509, Preoperational Inspection and Physical Characteristics.
- I. MTP 5-3-506, Compatibility with Related Equipment.
- J. MTP 5-3-507, Human Factors Engineering.
- K. MTP 10-3-504, Maintenance Evaluation.

5. SCOPE

5.1 SUMMARY

The procedures given in this MTP provide general guidance for determining the degree to which lighting, ventilation, air conditioning, and heating equipment meet current military requirements in vehicles and equipments.

The specific tests to be performed, along with their intended objectives are as follows:

a. Lighting - The objective of this subtest is to determine the adequacy of lighting provisions and their effects on crew performance relative to (1) emergency lighting, (2) instrument lighting, (3) work table lighting, (4) excessive lighting control, and (5) blackout operations.

b. Ventilation - The objective of this subtest is to determine the adequacy of forced air ventilating provisions and its effect on crew performance relative to (1) air circulation, (2) air filtration and noise control, and (3) protection against entry of flowing water or rain.

c. Air Conditioning - The objective of this subtest is to determine the adequacy of air conditioning provisions and its effects on crew performance relative to (1) regulation of compartment air temperature and efficiency, (2) air quality and noise control, (3) temperature stability and humidity control with normal working complement and traffic, and (4) power source to support air conditioner and associated system requirements.

d. Heating - The objective of this subtest is to determine the adequacy of forced air heating provisions and its effect on crew performance

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relative to (1) heater performance with normal working complement and traffic, (2) air quality and noise control, and (3) power source to support heater and associated system requirements.

e. Compatibility - The objective of this subtest is to determine the compatibility between the environment control equipment and the test item in which it is installed relative to (1) electrical power demand, (2) radio frequency interference, (3) damage from leakage or discharge of condensed water, exhaust from combustion heaters, or leakage of lubricants and refrigerants, and (4) marginal or degraded operation caused by power source requirements, (transient and full power requirements).

f. Maintainability - The objective of this subtest is to determine ease or difficulty of maintaining the environmental control components of the test item relative to (1) adjustments, cleaning filters, replenishing fuels, lubricants, refrigerants, (2) frequency of scheduled and unscheduled maintenance requirements and lengths of down time, (3) ease of removal and replacement of units and adequacy of tools.

5.2 LIMITATIONS

This MTP is limited to determining the adequacy of compartment lighting and environmental control equipment, installed in military vehicles and equipment. Excluded from this document are items of optical instrument lighting and items of radiant heating equipment.

6. PROCEDURES

6.1 PREPARATION FOR TEST

a. Ensure that assigned personnel have been trained in the operation and maintenance of the environment control equipment in accordance with applicable sections of MTP 5-3-503, and individual equipment publications.

b. Record all service personnel:

- 1) Identity and Rank
- 2) MOS
- 3) Training time in MOS
- 4) Experience in MOS
- 5) Training time on subject test item

c. Ensure that the environmental equipment has been subjected to the preoperational and physical inspections in MTP 5-3-500, and that the equipment is in normal working order.

d. Install and precheck all recording instrumentation. Attention shall be given to instrumentation location to avoid interference with crew duties. Temporary instrumentation for other measurements shall be used and removed as required.

e. Prepare record forms for systematic entry of data, chronology of test, test results, and such observations and measurements that would be of value in analysis and final evaluation.

6.2 TEST CONDUCT

NOTE: The concept of this test procedure is to observe the performance of crew members under all operating conditions and environments as required by QMR and the Plan of Test for the subject test item. When crew comfort or functioning is impaired by conditions attributable to lighting, ventilating, air conditioning, and heating equipment or by needs for extra protective clothing, the conditions responsible are to be identified and documented. When operation of the subject test item is impaired by characteristics of the environmental control equipment, the condition shall be identified and the source of difficulty located and recorded. When excessive maintenance operations are observed which are associated with the environmental control equipment, the locations and causes shall be recorded. Documentation of deficient operation shall be accomplished as much as possible by qualitative observations. Quantitative measurements of an Engineering Test nature will be avoided, except when essential to define the condition.

6.2.1 Lighting

6.2.1.1 Normal Operation

a. Observe and evaluate lighting conditions in the compartment during conduct of service test operations, together with the performance of assigned tasks by crew members, with attention to the following:

- 1) Adequate general illumination and lighting contrast during daylight hours. Absence of reflections and glare.
- 2) Adequate illumination and lighting contrast for panels and instruments during daylight hours.
- 3) During conditions of darkness, repeat the observations of steps a and b. Check the adequacy of emergency lighting.
- 4) Check the adequacy of illumination on work tables, and check that the intensity of general or special purpose illumination can be controlled to maintain subdued lighting where required.
- 5) Check that interior illumination is restricted to provide for blackout operations as applicable.

b. Repeat the evaluations of paragraph 6.2.1.1 during adverse weather conditions, including:

- 1) Heavy rain with wind
- 2) Frigid temperatures with snow
- 3) Extreme external illumination (lightning, pyrotechnics, etc.)

6.2.2 Ventilation

6.2.2.1 Normal Operation

a. Observe and evaluate the compartment atmosphere provided by ventilation equipment, and its effects on crew performance of assigned tasks. Consider the following:

- 1) Effects of air circulation: sufficiency of volume flow, impingement of air currents on personnel.
- 2) Quality of air: location of clean air inlets, adequacy of filters control of ventilation noise. Note presence of dust, fumes, or other foreign matter.

b. Repeat the evaluations of paragraph 6.2.2.1 during adverse conditions, including:

- 1) Extreme dust conditions
- 2) Heavy rain with wind

c. Check the ventilation intake during heavy rain or external water flow conditions to confirm that protective devices function satisfactorily to exclude water from the system.

6.2.3 Air Conditioning

6.2.3.1 Normal Operation

a. Observe and evaluate the compartment air temperature regulation and circulation provided by air conditioning equipment, and its effects on crew performance of assigned tasks. Consider the following:

- 1) Effects of external temperature: stability of temperature regulation in response to external changes (internal versus external temperature levels with time).
- 2) Effects of internal activity: stability of temperature and humidity control with normal working complement and normal traffic.
- 3) Effects of air circulation: comfortable temperature range, sufficiency of volume flow, impingement of air currents on personnel.
- 4) Quality of air: relative humidity, presence of dust, fumes, or other contaminants, control of air conditioner noise.
- 5) Capacity of power source to supply air conditioner and associated system power demands, including starting and regulating transients.

b. Repeat the evaluations of paragraph 6.2.3.1 during adverse conditions, including:

- 1) Extreme heat and dust
- 2) Hot temperatures with high humidity
- 3) Moderate temperatures with heavy rain

6.2.4 Heating

6.2.4.1 Normal Conditions

a. Observe and evaluate the compartment air temperature and circulation provided by forced air heating equipment during cold weather operations, and its effects on crew performance of assigned tasks. Consider the following:

- 1) Effects of external temperature: stability of temperature control in response to external changes (internal versus external temperature levels with time).
- 2) Effects of internal activity: stability of heater control with normal working complement and traffic.
- 3) Adequacy of heating: avoidance of use by crew members of protective clothing of a nature which could interfere with performance of duties.
- 4) Effects of air circulation: comfortable temperature range, impingement of air currents on personnel.
- 5) Quality of air: presence of contaminants, such as heater exhaust products or dust, control of heater noise.
- 6) Evaluate the adequacy of heat energy provisions: fuel supply and quantity, as applicable, electrical power from power source sufficient to support heater and associated system requirements, including starting and regulating transients.

b. Repeat the evaluations of paragraph 6.2.4.1 during adverse conditions, including:

- 1) Freezing temperatures with sleet
- 2) Frigid temperatures with snow and wind

6.2.5 Compatibility

a. Observe and evaluate compatibility effects between environment control equipment and the test item in which it is installed, in accordance with applicable sections of MTP 5-3-506.

b. Record adverse effects in the following areas:

- 1) Electrical power demand, and effects at point of connection with test item electrical system.

- 2) Radio frequency interference arising in environment control equipment, as experienced in electronic or communications equipment.
- 3) Damage to test item components from leakage or discharge of condensed water from air condition equipment, or exhaust from combustion heaters, or leakage of lubricants and refrigerants.
- 4) Any indication that power requirements of environment control equipment and associated systems are marginally satisfied, or insufficiently satisfied, by the power source of the subject test item, considering transient demands and full power requirements elsewhere on the test item.

6.2.6 Maintainability

a. Observe and evaluate the experience during maintenance operations, at each applicable echelon of maintenance, with respect to environment control components of the subject test item, in accordance with applicable provisions of Army Regulation 705-50 and instructions in MTP 10-3-504.

b. Record adverse experience in the following areas:

- 1) Excessive servicing requirements: adjustments, cleaning filters, replenishing fuels, lubricants, refrigerants.
- 2) Frequency of scheduled and unscheduled maintenance requirements and lengths of down time.
- 3) Ease of removal and replacement of units and components, and adequacy of tools.
- 4) Availability of spare parts, compared with requirements.
- 5) Abilities of personnel to perform maintenance operations under applicable extremes of weather and environment.

6.3 TEST DATA

6.3.1 Preparation for Test

Data to be recorded prior to testing shall include but not be limited to:

a. Personnel Data

- 1) Name, rank, and service number of each test soldier.
- 2) MOS
- 3) Training time in MOS, (weeks)
- 4) Experience in MOS, (months)
- 5) Training time on test item, (weeks)
- 6) Physical characteristics

- b. Nomenclature, serial number and manufacturer's name of the test item.
- c. Record inspection data as collected under applicable sections of MTP 5-3-500. Record accumulated operating time in hours on units of environment control equipment, as applicable.
- d. Record location of fixed instrumentation. If photographic records are made annotate photographs to identify all placement points and special considerations.

6.3.2 Test Conduct

6.3.2.1 Lighting

Record observations and comments of operators regarding quality of illumination under conditions of the test. Record illumination levels in foot candles only in instances of inadequate or excessive lighting, annotated to show external and/or required subdued illumination condition. Photograph instances of excessive glare. Photograph instances of blackout violation.

6.3.2.2 Ventilation

Record observations and comments of operators regarding adequacy of ventilation equipment. Record presence of carbon monoxide in atmosphere of compartment. Record air velocity around operators in feet per second, only when discomfort from air impingement is complained of by personnel. Record qualitative observations when inadequate dust protection is noted, and annotate records to show, by type of operational activity, external dust conditions. Record noise levels in db. Photograph inadequate water protective devices on ventilation intake.

6.3.2.3 Air Conditioning

Record observations and comments of operators regarding adequacy of air conditioning equipment. When documentation is necessary, record temperature in degrees F, relative humidity in percent, versus time, annotated to show external ambient conditions of air temperature, humidity, solar radiation, number of individuals served. Record air velocity around operators in feet per second, only when discomfort from air impingement is a complaint. Record noise levels in db. Record power demand data only if overload conditions are observed.

6.3.2.4 Heating

Record observations and comments of operators regarding adequacy of heating equipment. When documentation is necessary, record compartment air temperature versus time, annotated to show external ambient conditions of temperature, wind velocity and relative direction, precipitation, solar radiation, number of individuals served. Record air velocity in feet per second around operators only when discomfort from an impingement is a complaint. Record qualitative observations of gas contamination of air only when contamination is a problem. Record sound levels in db only if heater noise causes

difficulties.

6.3.2.5 Compatibility

Record data on compatibility as collected under applicable sections of MTP 5-3-506. Record observations of adverse effects by comments of operators, readings of test item monitoring instruments, and photographs of significant conditions. Record operating modes of all subject test item equipment contributing to peak demand on power source.

6.3.2.6 Maintenance

Record data on maintenance experience with environmental control equipment as collected under applicable sections of MTP 5-3-505.

6.4 DATA REDUCTION AND PRESENTATION

Processing of test data shall, in general, consist of organizing, marking for identification and correlation, and grouping of test data according to subtest title. Test criteria or test item specifications where required, shall be noted on the test data presentation to facilitate analysis and comparison. Where necessary, test data measurements shall be converted to be compatible with units given by test criteria or specifications.

Data - including operator's observations and comments - shall be summarized, compared, and evaluated according to procedures described in this and the referenced MTPs, or equivalent current practice when not otherwise specified. Appropriate charts, graphs, and tables shall be used as necessary to display summaries and comparisons of test data. Coordinates and other features of charts, graphs, and tables will be selected for clarity and uniformity with like presentations in other reports. Special consideration shall be given to any circumstance or condition which may have significantly influenced test results.

Environment control quantitative data and human performance criteria and limits will be found in MTP 5-3-507. Data collected under this procedure shall be referred to applicable criteria and limits. However, the governing criteria for the evaluations and summaries of this procedure shall be the comfort levels and performance capabilities of personnel operating the test item, and the ability of the subject test item power source to supply power demands.

Calculations shall be performed as specified by the individual referenced MTPs, or in accordance with equivalent current practice when not otherwise specified. All photographs, motion pictures, recorder charts, video tapes, and other records shall be explicitly identified and referenced; significant frames, transcriptions, and samples shall be selected for illustrative purposes. All illustrations shall be completely identified.

Data collected under adverse weather conditions shall be separately compared with data collected during normal conditions.

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Proponent has reviewed the documents in question and provided the following updated distribution statements. Please note that the last two documents do not belong to HQ DTC.

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